44. A mobile unit comprising a microphone module according to claim 43, wherein the mobile unit is selected from the group consisting of hearing aids, cellular phones, and head-sets.

A15 cont'd

45. A mobile unit comprising a sigma-delta-modulator according to claim 41, wherein the mobile unit is selected from the group consisting of hearing aids, cellular phones, and head-sets.--

REMARKS

Claims 1-35 have been canceled, and claims 36-45 have been added as a result of this response. Claims 36 and 42 are independent claims.

DRAWING OBJECTIONS

The Examiner has objected to Figs. 1 and 2 for not being labeled --Prior Art--. The Applicant directs the Examiner's attention to the Drawing Correction Approval Request, filed concurrently herewith, which amends Figs. 1 and 2 such that they are labeled --Prior Art--. Reconsideration and withdrawal of the objection is respectfully requested.

TITLE

The Examiner has objected to the title for not being descriptive. Applicant directs the Examiner's attention to the amendment made to the title, adopting the Examiner's suggestion of "SIGMA DELTA MODULATOR HAVING ENLARGED DYNAMIC RANGE DUE TO STABILIZED SIGNAL SWING". Reconsideration and withdrawal of this objection is respectfully requested.

OBJECTION TO THE SPECIFICATION

The Examiner has objected to the specification due to minor informalities, most notably with respect to differences between European and American English. Applicant has amended the specification to modify the instances identified by the Examiner, as well as any others, to adapt the present specification to commonly accepted American English. Reconsideration and withdrawal of this objection is respectfully requested.

CLAIM REJECTIONS

The Examiner has objected to claims 27 and 32 due to minor informalities. This rejection is moot in light of the cancellation of these claims.

35 U.S.C. §112, FIRST PARAGRAPH REJECTION

Claims 30 and 35 have been rejected under 35 U.S.C. §112, first paragraph. This rejection is moot in light of the cancellation of these claims.

35 U.S.C. §112, SECOND PARAGRAPH REJECTION

Claim 5 has been rejected under 35 U.S.C. §112, second paragraph as being indefinite. This rejection is moot in light of the cancellation of claim 5 and further inapplicable to new claims 39 and/or 40.

35 U.S.C. §102(b) MITTEL REJECTION

Claims 1-9 and 28-29 have been rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,986,598 to Mittel. This rejection is moot in light of the cancellation of claims 1-9 and 28-29 and further inapplicable to new claims 36-42, for at least the reasons set forth below.

Applicant respectfully submits that Mittel does not disclose the subject matter claimed in new claim 36. New claim 36 requires that signal amplitude progressively increases in a modulator from an integrator closest to the input of the modulator to more remote modulators in order to circumvent a situation where intermediate stages saturate and thereby cause non-linearity resulting in degraded performance, i.e. signal to noise ratio and/or distortion. This recitation distinguishes new claim 36 from Mittel.

Mittel discloses an arrangement in which the spontaneous oscillation problem is partly solved. In column 3, lines 8 to 14 of Mittel, there is disclosed that *"... the feedforward path 170 stabilizes the integrator swings without compromising other performance parameters. Consequently, the signal swing of the integrators is substantially independent of the level of the input signal."* Consequently, Mittel is silent about the subject matter of new claim 36 regarding a method of adjusting signal swings in a design phase. One reason for Mittel not addressing the issue of optimizing signal swings of the integrators is that the arrangement of Mittel relates to the field of wireless communication devices (column 1, lines 13-16) where a supply voltage of 3 V is normal. With a supply voltage of 3 V it is not a problem to design ideal integrators using CMOS technology.

However, for example within hearing aids a supply voltage of less than 1 V is typical, dynamic range limitations give rise to implementation problems that are unknown within applications providing higher supply voltages, such as the field to which Mittel relates. These problems are taken into account by the method of claim 36 which serves to improve the function of the integrators so as to utilize the low supply voltage available so as to produce an acceptable stable input amplitude, still with a low power consumption due to the signal swing of the integrators.

It is to be borne in mind that it is conventional practice when designing low noise audio circuits to achieve as high a gain, and thereby a high signal swing, as early as possible in a signal path in order to enhance signal to noise ratio. In contrast to the conventional approaches, the Applicant has appreciated that an acceptable signal to noise ratio can be achieved even with a low signal swing at the earliest integrators of the signal path.

Thus, the Applicant respectfully submits that new claim 36 is novel pursuant to 35 U.S.C. 102, and in addition involves an inventive step pursuant to 35 U.S.C. 103(a) with respect to Mittel.

Applicant submits that new claim 37 (which roughly corresponds to original claim 3) is novel pursuant to 35 U.S.C. 102, and in addition involves an inventive step pursuant to 35 U.S.C. 103 (a) with respect to Mittel by virtue of its dependency on independent claim 36, for at least the reason set forth above.

With respect to new claim 38 (which roughly corresponds to original claim 4), Applicant submits that there is no basis either in the drawings or in the description of Mittel that signals illustrated in figures 3 to 5 correspond to less than 20% of full scale signal level as such full scale signal level is not defined in Mittel. No marks are shown on the graphs that indicate to the reader that amplitudes of two different curves could be assumed to have the same scale. Even if it were so, figures 3 to 5 are used by Mittel to schematically

illustrate the function of his modulator, therefore signal swings indicated in these figures are not combined with adjustment of integrator gain factors.

It is therefore respectfully submitted that subject matter of new claim 38is novel pursuant to 35 U.S.C. 102, and in addition involves an inventive step pursuant to 35 U.S.C. 103 (a) with respect to Mittel.

With respect to new claims 39 and 40, Applicant has addressed the Examiner's objection. New claim 39 includes the first part of original claim 5, *"...adjusting gain parameters of the integrators."* New claim 40 is added as a subclaim to new claim 39 relating to adjusting *feedback* gains. Via claim dependency to claim 36 the Applicant submits that new claims 39 and 40 are novel pursuant to 35 U.S.C. 102, and in addition involves an inventive step pursuant to 35 U.S.C. 103 (a) with respect to Mittel.

Original claim 6 has been replaced by new claim 41 in order to increase clarity. Via claim dependency of new claim 36, the Applicant submits that new claim 41 is novel pursuant to 35 U.S.C. 102, and in addition involves an inventive step pursuant to 35 U.S.C. 103(a) with respect to Mittel.

New claim 42 is a modified version of original claim 7 since the subject matter of original claims 8 and 9 has been included. It is now also specified that in addition to the comparator used for signal quantizing, a sigma-delta converter according to new claim 42 comprises controlling means for generating a control signal so as to control signal swings of the integrators.

The comparator 180 disclosed by Mittel (figure 1, and column 2, lines 56-63) is a comparator for signal quantification which is a necessary part of a sigma-delta converter. In new claim 42, the term the controlling means serves to prevent oscillation problems of the modulator. This is not disclosed by Mittel, and there is nothing in Mittel that addresses the issue of preventing oscillation.

It is therefore submitted that new claim 42 claims subject matter which is novel pursuant to 35 U.S.C. 102, and in addition involves an inventive step pursuant to 35 U.S.C. 103 (a) with respect to Mittel.

In view of the above amendments and remarks, reconsideration of the rejection and allowance of claims 36-42 is respectfully requested.

35 U.S.C. §103(a) MITTEL REJECTION

Claims 26-27 have rejected under 35 U.S.C. §103(a) as being unpatentable over Mittel. This rejection is moot in light of the cancellation of these claims.

UNDER 35 U.S.C. §103(a) MITTEL/PUTHUFF

Claims 14-19 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Mittel in view of U.S. Patent No. 6,112,103 to Puthuff. This

rejection is moot in light of the cancellation of claims 14-19 and further inapplicable to new claims 43-45, for at least the reasons set forth below.

Original claims 14-17 have been redrafted into new claims 43 and 44. Via claim dependency of new claim 41, the Applicant submits that new claims 43 and 44 are novel pursuant to 35 U.S.C. §102, and in addition involves an inventive step pursuant to 35 U.S.C. §103(a) with respect to Mittel .

Original claims 18-19 have been redrafted into new claim 45. Via claim dependency of new claim 41, the Applicant submits that new claim 45 is novel pursuant to 35 U.S.C. §102, and in addition involves an inventive step pursuant to 35 U.S.C. §103(a) with respect to Mittel.

In view of the above amendments and remarks, reconsideration of the rejection and allowance of claims 43-45 is respectfully requested.

CONCLUSION

In view of the above amendments and remarks, reconsideration of the various objections and rejections and allowance of claims 36-45 is respectfully requested.

If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number listed below.

Pursuant to 37 C.F.R. 1.17 and 1.136(a), the Applicants respectfully petition for a one (1) month extension of time for filing a response in connection with the present application, and the required fee of $110.00 is attached.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Very truly yours,

HARNESS, DICKEY & PIERCE, PLC

By_____
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Please amend the specification as follows:

On page 1, please amend the second full paragraph, containing lines 14-20, with the following paragraph:

-- SDMs have received much attention in recent years. The combination of over-sampling and noise shaping has revealed performance levels, which were not achievable just a few years ago in integrated circuit technology. The principle can be used in many applications. Examples such as analog [analogue] to digital converters, digital to analog [analogue] converters, phase locked loops, PDM systems, PWM systems etc. have proven the versatility of this principle. The basic idea is that clock frequency is traded off for resolution.--

On page 2, please replace the second full paragraph, containing lines 10-17, with the following paragraph:

--One bit single loop SDMs comprise a plurality of integrators embedded [imbedded] in a feedback loop with a plurality of feedback branches. This topology forms the feedback filter 102 and the pre-filter 101. It can be shown that the NTF is a high pass filter function while the STF is a low pass filter-

function. I.e. the quantization noise is suppressed at low frequencies while the low frequency input signal is passed unaffected through the modulator. A subsequent filter, digital or analog [analogue], can then remove the high frequency noise thus leaving the low frequency part of the signal with an improved signal to noise ratio.

On page 2, please replace the third full paragraph, containing lines 19-22, with the following paragraph:

--When designing a SDM it is the design of the filter, which influences the performance of the SDM. It is of interest to choose the order and the coefficients of the filter in such a way that the noise is minimized [minimised] in the frequency range of interest.--

On page 3, please replace lines 8 and 9 with the following:

--To [summarise] summarize, the trade-offs when choosing the cut-off frequency in the NTF are:--

On page 3, please replace the third full paragraph, containing lines 16-20, with the following paragraph:

--According to the above, it is therefore of interest to design the filter in such a way that the optimal cut-off frequency is chosen - meaning a cut-off

frequency resulting in maximum MSA vs. noise ratio - i.e. maximum signal to noise ratio (SNR_{max}). For each order of SDM's and NTF filter function an optimum NTF cut-off frequency exists for which the SNR_{max} is maximized [maximised].--

On page 4, please replace the first paragraph, containing lines 1-3, with the following paragraph:

--It is therefore of interest to establish a new and optimized [optimised] design route for SDMs to ensure maximum DNR and stability while keeping the distortion in the output signal at a minimum for input signals exceeding MSA.--

On page 4, please replace the fourth full paragraph, containing lines 13-15, with the following paragraph:

--It is an object of the present invention to provide a new and optimized [optimised] design route for SDMs for low power and low voltage applications to ensure maximum DNR, maximum SNR_{max} and maximum stability.--

On page 4, please replace the last paragraph, containing lines 35-37, with the following paragraph:

--By cascaded integrators is meant that an integrator output is connected to the input of a following integrator. An integrator can in an embodiment be [realized] realised using digital or analog electronics.--

On page 5, please replace the first paragraph, containing lines 1-4, with the following paragraph:

--A comparator is a component transforming the amplitude continuous [continuos] input signal to an amplitude discrete output signal having either a first or a second value. The input of the SDM may be the input of the first integrator in the cascade of integrators.--

On page 6, please replace the third paragraph, containing lines 10-13, with the following paragraph:

--Thus, if the signal swing at the output of the integrators should become close to unstable (the predefined threshold value) the reduction with the predefined factor or value ensures that instability never occurs and the integrators' [integrators] signal swing remains stable.--

On page 7, please replace the second paragraph, containing lines 6-7, with the following paragraph:

--MSA_{rms} may be derived from the Gaussian [Gausian] ability criterion by solving the equation:--

On page 9, please replace the third paragraph, containing lines 10-17, with the following paragraph:

--In audio-related applications it is primarily the low frequencies that are important. The reason for this is that the human ear is only sensitive to such low frequencies. In figure 2 the important frequencies are below the dashed line 203 - therefore the noise should be [minimised] minimized in this frequency range. As already mentioned this can be done by increasing the order of the filter or by moving the NTF cut-off frequency to higher frequencies, although by increasing the NTF cut-off, the MSA will be lowered. Contrary, a lower NTF cut-off frequency results in more noise and higher MSA.--

On page 11, please replace the fourth full paragraph, containing lines 26-33, with the following paragraph:

--The signal swing after each integrator is monitored 602 and, in a preferred embodiment, the output of the first two integrators are minimized [minimised] by adjusting the coefficients of these integrators 603. When the coefficients of these integrators have been adjusted, the remaining integrator coefficients are adjusted 604 in such a way that the signal swings after the

third integrator and the following integrators have a larger signal swing than the signal after the first and the second integrator. The SDM now complies with the above-mentioned advantages.--

On page 12, please replace the sixth full paragraph, containing lines 30-38, with the following paragraph:

--Resetting is in fact not always necessary in order to maintain stability. In order to maintain stability it may only be necessary to multiply (or subtract [substract]) the state variable of the integrator by a factor which ensures that the output of the integrator will not increase in a uncontrollable way. This clamping procedure ensures that the modulator can be operated in an overload mode where it is capable of handling a signal larger than MSA. In fact it can be designed so that the maximum input can be as large as the full scale output signal level of the quantizer (assuming for simplicity that a_1 equals b_1) whereby a much larger dynamic range is obtained. Combined with the design procedure for the NTF this means that the SDM will have a much larger DNR than conventionally operated SDMs. Furthermore, much lower distortion at high output signal levels can be achieved compared to conventionally operated SDM's.--

IN THE CLAIMS

Please cancel claims 1-35 without prejudice or disclaimer to the subject matter contained therein.

Claims 36-45 have been added by way of this Amendment.